



中国科学技术大学

University of Science and Technology of China

HGTD activities at USTC

USTC HGTD group

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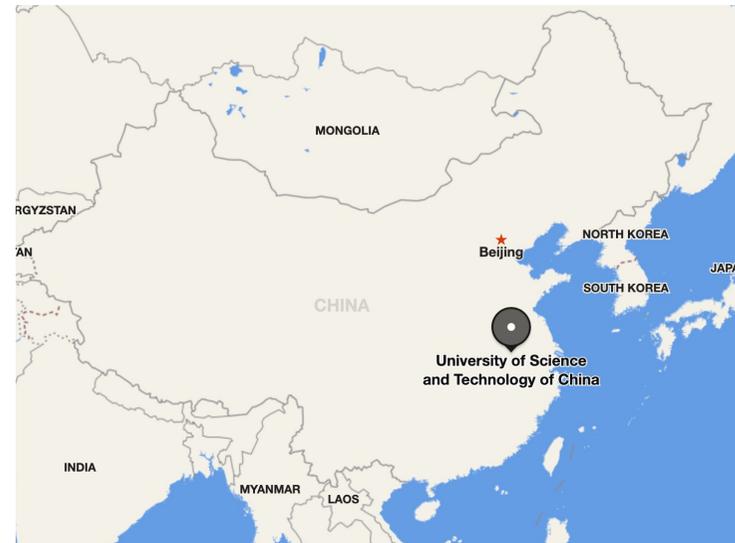
USTC HGTD group

Particle and Nuclear Physics

Department of Modern Physics

University of Science and Technology of China

Anhui, Hefei, China



HGTD project at ATLAS and USTC involvement

- High Granularity Timing Detector (HGTD) is an upgrade project for HL-LHC (to be installed during 2026 – 2028) to mitigate the high pile-up running condition by adding timing info [\[TDR\]](#)
- Sensor technology: Low-Gain Avalanche Detector (LGAD), will be installed at $2.4 < |\eta| < 4.0$, time resolution per hit $35 \sim 70$ ps up to NIEL of $2.5E15 \text{ cm}^{-2}$ Si 1 MeV n_{eq})
- USTC responsibilities in sensor and assembly RD: design and fabricate 10% of the sensors and assemble 10% of the detector modules

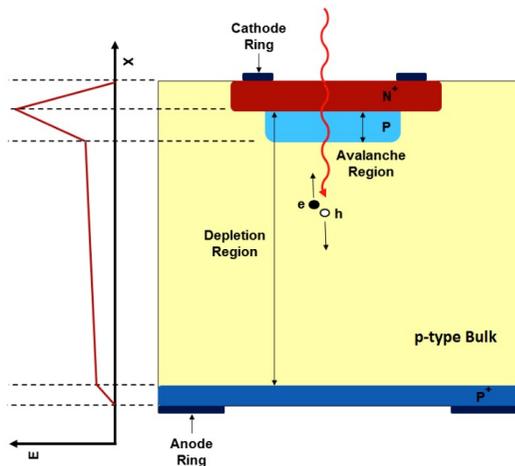
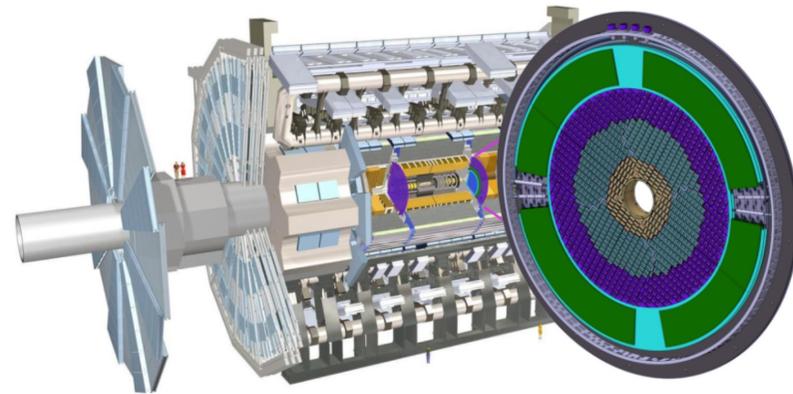


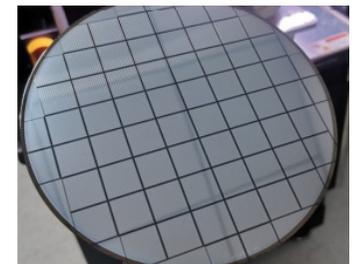
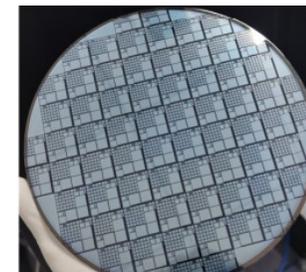
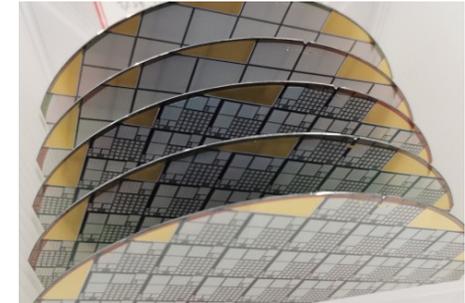
Illustration the LGAD technology



Planned installation location of HGTD in ATLAS

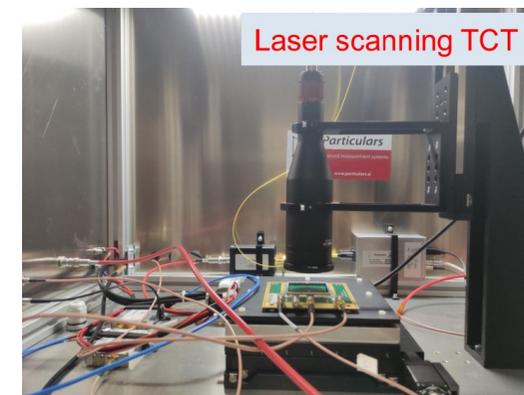
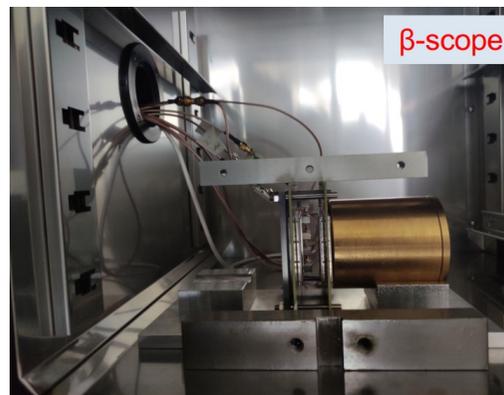
USTC LGAD RD milestones

- 2019.7 first design completed
- 2019.9 initial discussion about the fabrication with Institute of Microelectronics (IME, CAS)
- 2020.7 delivery of USTC-IME-1.0 LGAD
- 2020.11 delivery of USTC-IME-1.1 LGAD
- 2021.5 – 2021.10 USTC-IME-2.0 production
- 2021.11 – 2021.12 USTC-IME-2.1 production
- Samples of all versions are extensively tested
 - Irradiated with reactor neutrons
 - Electrical properties characterized with probe station
 - Time resolution, efficiency and charge collection measured with infrared laser, beta source and test beams at DESY and CERN
- 2022.8 USTC-IME-2.x passed design specifications preparing for production



USTC lab resources for sensor tests

- Probe station equipped with a cooling system
- Sr-90 beta-scope (inside an environment chamber)
- Infrared-laser TCT
- (a dedicated clean room of 270 m² for HGTD assembly)



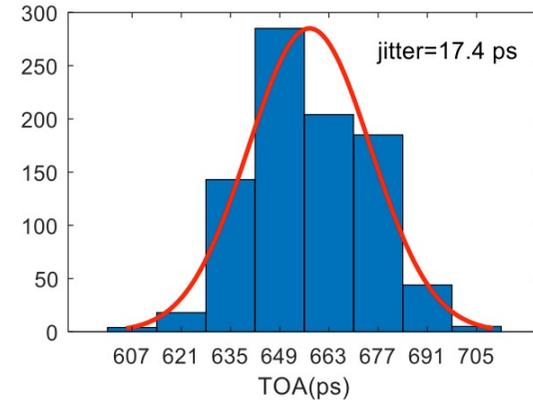
USTC Center for Micro-and Nanoscale Research and Fabrication

- Our work is strongly supported by the USTC NRFC that is equipped with devices for semi-conductor processing and testing housed in 3 clean rooms (surface:1200 m² in total)
 - e.g Lithography, etching, coating, dicing, wedge-bonding

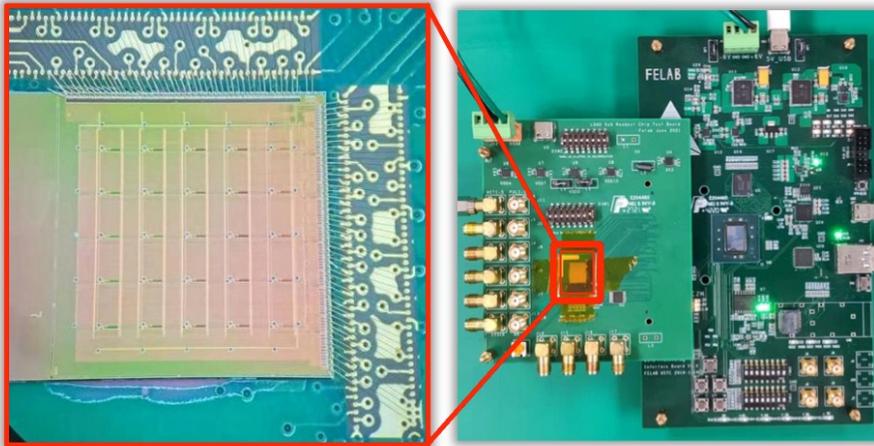


Readout ASIC for LGAD

- Working on the readout ASIC for LGAD, which will be bump bonded to sensors directly.
- The 1st version prototype ASIC has been tested:
 - 25 channels: 5 x 5 pixel matrix
 - Preamplifier, discriminator +TDC inside in the ASIC
 - Input charge: 5~40 fC
 - Time resolution: jitter < 25 ps @ 10 fC



Time resolution @ 10 fC input charge



channels with a common source preamp integrated

18.56	15.04	11.3	9.66	10.19
13.55	11.58	14.56	10.86	9.59
16.45	15.96	16.49	15.87	17.4
15.54	14.77	13.78	10.76	9.35
14.4	12.14	12.29	11.03	10.03

channels with a common gate common source preamps integrated

USTC HGTD team and the plan

- Faculty: **Lei Zhao**, **Hao Liang**, Yanwen Liu, Yongjie Sun, Yusheng Wu, Lailin Xu, Zhengguo Zhao
- Postdocs: Quanyin Li, **Jiajin Ge***, Jiajun Qin
- Students: **Yongkang Cai**, **Han Chen***, Chihao Li, Han Li, Kuo Ma, Tao Wang, Anan Wang, Xiao Yang, **De Zhang**, Xiangxuan Zheng

Blue = detector

Red = electronics

* Members that have left

The plan:

- Thinking how to involve in EIC LGAD project:
Sensor R&D and fabrications, ASIC, simulations ...
- Manpower and fundings